REMARKS/ARGUMENTS

Claims 37-52 are active in the case.

Pursuant to the Examiner's request on page 4 of the Official Action, Applicants are resubmitting the Form PTO 1449 filed with the Information Disclosure Statement on January 15, 2002 and providing full dates for all of the Japanese references. It is noted that Reference AQ 11-315570 is a typographical error and should refer to 11-312570. This reference was considered in an Information Disclosure Statement subsequently filed on August 30, 2002 and was initialed therein so the Examiner may wish to cross out reference AQ.

The specification is amended on page 31 to change the phrase "CO gas" to "CO_2 gas". Basis for this amendment may be found on page 28, lines 23-31 of the specification.

Basis for new Claims 37-48 may be found in the claims as originally filed and in the claims as amended in the Preliminary Amendment filed March 6, 2002.

Further basis for new Claims 37 and 43 may be found on page 33, lines 34-35 and Figures 1 and 10 in the specification. Further basis for Claims 42 and 48 may be found on page 9, lines 28-34 of the specification. Further basis for Claims 40 and 46 may be found on page 26, lines 24-26 of the specification. Further basis for Claim 49 may be found on page 10, lines 2-9 of the specification. Further basis for Claim 50 may be found on page 17, lines 1-2 of the specification. Further basis for Claims 51 and 52 may be found on page 16, lines 18-23 of the specification. No new matter has been entered into the specification and new claims.

The rejection of Claims 23-30 and 35 under 35 U.S.C. §102(b) as anticipated by JP 3-5375 and JP 5-229871, each taken alone, is traversed.

JP 3-5375 discloses a method of making a sintered compact of an AlN sintered body. The method discloses adding 0.1 to 3.0 wt. % of amorphous carbon to AlN powder and

compacting into the desired shape. The resulting green compact is subjected to deoxidation treatment at 1500°C to 1700°C in a non-oxidizing atmosphere and then sintered at 1700°C to 2200°C to produce an AlN sintered compact having <u>high thermal conductivity</u>. JP 3-5375 also teaches on page 3, upper left column, lines 9-17 that the heating treatment makes the amorphous carbon bind with oxygen atoms contained in the AlN powder and to be emitted as CO or CO_2. By the above treatment it is possible to reduce the oxygen content of the AlN sintered body. Even when no sintering aid is used or the purity of AlN raw material powder is low, it is possible to obtain an AlN sintered body with <u>high thermal conductivity</u>.

Thus, as clearly taught above in JP 3-5375, the amorphous carbon is removed after it binds with oxygen and the AlN sintered body according to JP 3-5375 does not contain any carbon at all. Therefore, it is not possible for the worker of ordinary skill in the art to recognize from a consideration of JP 3-5375 the problem that the <u>volume resistivity</u> of an AlN sintered body containing crystalline carbon decreases at high temperature, which problem is solved by the teachings in the present application of the addition of amorphous carbon to AlN, either alone or in combination with crystalline carbon to arrive at an AlN sintered body which maintains <u>volume resistivity</u> at high temperature. Therefore, the claims are not anticipated by JP 3-5375.

JP 5-229871 discloses a production method for making a ceramic sintered body by adding a prescribed amount of a sintering aid and amorphous carbon to AlN powder, forming the resultant powder mixture into a compact of predetermined form, adjusting the carbon content of the compact within a predetermined range after a degreasing treatment, heating the compact for deoxidation and sintering the compact in a non-oxidizing atmosphere. In order to discuss the disclosure of JP 5-229871 certain translated paragraphs from the reference will be set forth below with underlining of certain pertinent areas.

[0012] As shown in Fig. 1, by decreasing the residual carbon content in the degreased body as much as possible, degree of sintering, namely density of the sintered body, deformation, and color shading are cancelled. On the one hand, in order to maintain a high thermal conductivity, it was found that a certain amount of residual carbon is required. A small amount of residual carbon reduces oxygen adhered to the raw material powder surface and an oxygen atom which exists as an oxide into CO and CO_2, and removes them out of the system. However, an excess amount of residual carbon forms a carbide, which obstructs conduction of heat as other impurities do, or obstructs the formation of the liquid phase which is necessary at the time of sintering, lowers degree of sintering and forms a sintered body with a low density and a low strength. (Underlining added)

[0013] Therefore, as described above, it is possible to obtain a sintered body with little deformation, little color shading, a high density and a high thermal conductivity by adjusting the amount of the residual carbon in the degreased compact within an appropriate range. However, in a conventional production method, it was very difficult to set the amount of residual carbon within a proper range. For example, when a sheet-form compact is formed from a raw material mixture comprising an organic binder and a degreased in air at a temperature of about 400°C, the amount of residual carbon is as small as 0.01 weight %. On the other hand, in the case of a large-sized compact, the discharge of the impurity becomes difficult, and the amount of residual carbon becomes excessive, in any case it was difficult to set the amount within the optimum range. (Underlining added)

[0014] To improve the property of the sintered body. It was found to be effective to keep the amount of residual carbon within a predetermined range by adding beforehand a

predetermined amount of a substance which works as a carbon source in the raw material AlN powder, and to carry out reduction removal f impurities such as oxygen by the residual carbon at the time of sintering. (Underlining added)

[0015] In other words, it was found that by adding a predetermined amount of amorphous carbon to the raw material AlN powder as an additive, and setting the amount of residual carbon before the sintering (i.e. after the degreasing) within a predetermined range, the amount of impurity oxygen in the sintered body can be decreased substantially, and a sintered body with little deformation, little color shading and a high strength can be obtained. (Underlining added)

As clearly indicated in the translated paragraphs from JP 5-229871 set forth above, a certain amount of carbon is contained in the degreased compact before sintering. Sintering of the degreased compact reduces oxygen contained in the raw material into CO and CO_2, thereby removing oxygen from the system. Further, any excess amount of residual carbon forms a carbide, which obstructs conduction of heat as other impurities do, or obstructs the formation of the liquid phase, which is necessary at the time of sintering, lowers the degree of sintering and forms a sintered body with low density and low strength (see translated paragraph [0012]). Therefore, JP 5-229871 teaches that the amount of residual carbon should be adjusted so that the resultant sintered body does not contain any carbon. Thus, the sintered body of JP 5-229871 does not contain amorphous carbon, as in the present claims. Accordingly, the worker of ordinary skill in the art would not recognize from the teachings of JP 5-229871, which is directed to producing a sintered compact of high-thermal conductivity, the problem that the volume resistivity of an AlN sintered body containing crystalline carbon decreases at a high temperature, nor does JP 5-229871 teach or suggest that the addition of amorphous carbon or carbon forming a solid solution, as in the present claims, is effective to

solve the problem of lowered volume resistivity encountered by the addition of crystalline carbon to an AlN sintered body. The claims are not anticipated by JP 5-229871.

The rejection of Claims 4-7, 9, 21-30 and 35 under 35 U.S.C. §102(a, b, or e) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Kobayashi et al and EP 757023 is traversed.

The improved effects of the present invention will become clear from a comparison between the examples and comparative examples in the present specification.

In Example 1 according to the invention, where the AlN sintered body contains amorphous carbon, the volume resistivity of the sintered body at 500°C is higher than 1×10^8 $\Omega \cdot$ cm. In Example 3 according to the present invention, where solid-solution of carbon is formed in the AlN phase, and volume resistivity of the sintered body at 500°C is also higher than 1×10^8 $\Omega \cdot$ cm. In contrast, in Comparative Example 2, where the AlN sintered body contains crystalline carbon, the volume resistivity of the sintered body at 500°C is less than 1×10^8 $\Omega \cdot$ cm (see Figure 1).

In Example 4 according to the present invention where the AlN sintered body contains both amorphous carbon and crystalline carbon and in Example 6 according to the invention where the amorphous carbon and crystalline carbon are used and a part of the carbon forms a solid-solution in the AlN phase, the volume resistivity of the product of Examples 4 and 6 at 500°C is higher than 1×10^8 $\Omega \cdot$ cm. In contrast, in Comparative Example 2 where the AlN sintered body contains crystalline carbon, the volume resistivity of the sintered body at 500°C is less than 1×10^8 $\Omega \cdot$ cm (see Figure 10). Thus, it can be seen that the addition of amorphous carbon or a solid-solution of carbon alone or in combination with crystalline carbon suppresses the decrease in the volume resistivity of the AlN sintered

body at a high temperature, as compared to an AlN sintered body containing crystalline carbon, alone.

The rejection over Kobayashi et al and EP 0757023 will be discussed with regard to particular sections of Kobayashi et al, since they are considered equivalent to one another.

Column 13, lines 29-40 of Kobayashi et al discuss a wafer-heating test plate having a diameter of 210 mm and a thickness of 10 mm was prepared from the AlN sintered body of Sample A1, according to the invention of Kobayashi et al, and was placed in a vacuum chamber equipped with a heating mechanism having an infrared lamp unit. A silicon wafer having a diameter of 8 inches was placed on this plate, thermocouples were fitted to the plate and the silicon wafer to simultaneously measure each of the temperatures thereon. As the infrared lamp unit twenty of 500 W infrared lamps having an infrared peak around a wavelength of 1 μm and fitted to a reflecting plate made of aluminum were used and these infrared lamps and the reflecting plate were arranged outside the vacuum chamber. The above indicates that an AlN sintered body is adapted to be used in a wafer-heating apparatus with an infrared lamp unit.

Each of the sintered bodies in Tables 5 and 6, A1 through A12 will now be discussed. The Example A1 is described in Kobayashi et al, column 27, lines 1-6 as follows: in test run A1 falling outside the scope of the invention of Kobayashi et al the content of carbon was 150 ppm and no carbon phase was detected by X-ray diffraction analysis. Example A1 does not fall within the scope of the present claims, since the lower limit of carbon is 200 ppm in the present claims. Further, since Example A1 does not fall within the scope of the invention of Kobayashi et al, it cannot be used in a wafer-heating apparatus, because it is not suitable for use at a high temperature. Finally, it is not possible to lower the brightness of the sintered body with such a small carbon content.

The Examples A2, A4, A6, A7, A9, A10, A11 and A12 all contain crystalline carbon (see Tables 5 and 6 and the discussion in column 27, line 1 through column 28, line 26). The crystalline carbon of these examples is different from amorphous carbon or carbon forming solid-solution in an AlN crystal phase. Therefore, all of these examples correspond to Comparative Example 2 of the present specification, discussed above, and would exhibit a low volume resistivity at high temperature.

Example A3 is described in column 27, lines 13-17 of Kobayashi et al and shows a content of carbon of 750 ppm, no carbon phase detected and the sintered body was white. Example A3 does not fall within the scope of the invention of Kobayashi et al and cannot be used for a wafer-heating apparatus, because it is not suitable for use at a high temperature. Therefore, the example does fall within the scope of the present claims.

Example A5, which is specifically mentioned in the Office Action, is described in Kobayashi et al at column 27, lines 23-31. In test run A5 the content of carbon was 750 ppm and in the resulting sintered body a phase $(AlN)_x(Al_2OC)_{1-x}$ phase was detected in addition to an AlON crystalline phase and a carbon phase was detected. The carbon contained in Example A5 does not form a solid solution, because if carbon forms a solid solution, it cannot be detected by X-ray analysis. The crystalline compound Al_2CO is also formed and detected by X-ray analysis. Therefore, the carbon contained in Example 5 is different from the carbon described in the present claims and like that in Comparative Example 2, discussed above.

Example A8 is described in Kobayashi et al at column 27, lines 34-38. Test run A8 falls outside the scope of the invention of Kobayashi et al, the content of carbon was 750 ppm and a polytype existed besides the AlN crystalline phase in the sintered body. Since Example A8 does not fall within the scope of the invention of Kobayashi et al, it cannot be used for a

wafer-heating apparatus, because it is not suitable for use at a high temperature. Therefore, the example does not fall within the scope of the present claims.

Examples B1, B2, B3, B4, B5, B6, B8, and B9 all contain crystalline carbon (see Tables 7 and 9 and columns 29 and 30 of Kobayashi et al). Therefore, these examples all correspond to Comparative Example 2 of the present specification, discussed above, and would have low volume resistivity at high temperature.

Example B7 is described in Kobayashi et al at column 31, lines 34-39. Test run B7 falls outside the scope of the invention of Kobayashi et al, no carbon phase was produced and the sintered body was white. Since Example B7 does not fall within the scope of the invention of Kobayashi et al, it cannot be used for a wafer-heating apparatus, because it is not suitable for use at a high temperature. Therefore, the example does not fall within the scope of the present claims..

Example B10 is described in Kobayashi et al at column 31, lines 41-49. In test run B10 carbon was detected in the resulting sintered body and the sintered body was white. The carbon contained in Example B10 does not form a solid solution, because, if carbon forms a solid solution, it cannot be detected by X-ray analysis. A crystalline compound Al_2CO was produced in Example B10 and was detected in the X-ray analysis. Therefore, the carbon contained in Example B10 is different from the carbon described in the present claims.

Finally, the Examiner states that in Examples B1 through B10 substantially more carbon is added to the sintered body than carbon detected and, therefore, it would be expected that some is amorphous, because a resin may be used to form the carbon and would produce amorphous carbon. However, it is clear that during the sintering process some of the carbon will be consumed and produce CO and CO_2 gas, which would account for the discrepancy between added carbon and carbon resulting in the sintered body. Therefore, it is clear that the

carbon set forth in the above-mentioned examples usable in the invention of Kobayashi et al would not contain amorphous carbon, but only crystalline carbon. The claims are not anticipated by and distinguish over the references.

The rejection of Claims 4-7, 9, 21-30 and 35 under 35 U.S.C. §102(b) as anticipated by JP 9-315867 is traversed.

The Japanese reference discloses an AlN sintered body containing 150 ppm to 0.5 % by weight of a rare earth element and 900 ppm or less of metal impurities except rare earth elements, and exhibiting a main peak in a wavelength range of 350 to 370 nm in a spectrum obtained by cathode luminescence. The reference discloses carbon content in Table 1. However, paragraph [0087] of the reference shows the content of carbon is in AlN raw material powder, not in the sintered body and a translation is reproduced below.

[0087] Hereinafter, the experimental results are described in more detail. Each of aluminum nitride sintered bodies shown in Tables 1 and 2, as well as Tables 3 to 6 was manufactured. As raw material powder, aluminum nitride powder obtained by a reductive nitriding method was used. The amount of oxygen and the amount of metal impurities in the raw material powder are shown in Tables 1, 3 and 5. A nitrate of yttrium was dissolved in isopropyl alcohol and an additive solution was prepared. Using a pot mill, the additive solution was mixed to aluminum nitride raw material powder. A mixed ratio of yttria calculated as Y_2O_3 an added amount of alumina are shown in Tables 1, 3 and 5.

As can be seen in the Table mentioned above, the content of oxygen contained in the AlN raw material powder is far larger than the content of carbon. With such a large amount difference between carbon and oxygen, as is taught in JP 3-5375 and JP 5-229871, carbon will be removed as CO or CO_2, after reacting with oxygen. This is clear from the color of the sintered bodies. Except for Comparative Examples 1 and 2 of the reference, the sintered

bodies in the examples of the reference are amber colored (Table 2). Since the color of highly pure AlN ceramic is amber, it is clear that carbon is not contained in the sintered bodies of the examples of the reference. With regard to Comparative Example 1 of the reference, the color is black not because of carbon, but because of the content of metal impurities, which can be as large as 5,000 ppm.

Further paragraphs from JP 9-315867 are reproduced below and will be discussed below.

[0059] Moreover, distribution of an oxygen concentration was measured by X-ray microanalyzer (EPMA) with respect to the sintered body of the present invention. As a result, it was found that relatively large amount of oxygen atoms form solid solution in grains in the sintered body of the present invention. (Underlining added)

[0060] In the sintered body of the present invention, it is assumed that a relatively large amount of oxygen atoms form solid-solution in aluminum nitride crystal grains, provide localized electronic level, and contribute to the decrease of resistance inside the grains. It is in compliance with the fact that the absorption peak in the ESR spectrum has a high intensity. (Underlining added)

[0061] When an oxygen concentration in an aluminum nitride crystal grain constituting the sintered body of the present invention was measured concretely, it was found that a concentration of 0.5% by weight or more, more preferably 0.6% by weight or more, is required. Moreover, although the upper limit does not particularly exist, the concentration is preferably 2.0% by weight or less, more preferably 1.0% by weight or less. (Underlining added)

[0062] Summarizing the above experimental results, it is speculated that the electric resistance of crystal grains was decreased due to the following process. Namely, when

oxygen formed solid-solution in aluminum nitride crystal grains, oxygen entered at the nitrogen lattice point (site) and was replace by nitrogen. By a compensation of an electric charge between nitrogen N^{3-} and oxygen O^{2-}, a conductive (donor) electron or an aluminum vacancy was generated, and contributed greatly to electric conductivity. By generation of such a conductive electron or a vacancy, electric resistance inside the aluminum nitride crystal grains was decreased, and supposedly contributed to a decrease of electric resistance of the sintered body. (Underlining added)

It is clear from the discussion above and the paragraphs reproduced above, that the AlN sintered bodies of JP 9-315867 do not contain carbon as in the present claims and that the material in solid solution in the sintered body is oxygen. Further, the reference teaches that the electric resistance of the sintered body is decreased by the formation of oxygen in solid solution. In contrast, the present invention teaches the maintenance of a high volume resistivity at a high temperature by the use of the amorphous carbon and/or a carbon forming a solid solution in AlN crystal phase of the present claims.

The report by NGK Insulators Ltd. referred to in the Official Action by the Examiner will be discussed further below.

JP 9-315867 discloses X-ray diffraction chart of the sintered body. It is not clear from the chart whether or not a carbon peak exists.

According to the report submitted by NGK Insulators Ltd., the sample of experiment No. 51 in JP 9-315867 was produced and X-ray diffraction analysis of the above sample was conducted. The report says that a characteristic peak of carbon was not detected on the X-ray diffraction chart.

It should be noted that JP 9-315867 does not teach about the production method of the sintered body in detail. In the paragraph [0016], it is only mentioned that the raw material

aluminum nitride powder was obtained by reduction nitridation. Since it does not teach about the condition of reduction nitridation, it is impossible to exactly identify the raw material. Further, it does not teach about the source of carbon at all.

Therefore, it is impossible to provide objective evidence that the raw material powder mentioned in the above report is the same as the raw material powder of JP 9-315867. It is highly doubtful that the sample described in the report submitted by NGK Insulators Ltd. is identical to the sintered body of JP 9-315867.

Accordingly, the report submitted by NGK Insulators Ltd. does not support the contention that the carbon peak does not exist on X-ray diffraction chart and the carbon does into solution. As discussed above, the sintered bodies of JP 9-315867 do not contain carbon. We respectfully request the Examiner to reconsider JP 9-315867 and the report submitted by NGK Insulators Ltd.

It is submitted that Claims 37-52 are allowable. Such action is respectfully requested.

Respectfully submitted,

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LIST OF REFERENCES CITED BY APPLICANT	APPLICANT Yasutaka ITO et al	
	FILING DATE July 10, 2002	GROUP 1755

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	FILING DATE IF APPROPRIATE
	AA	4,803,183	02/07/89	K.A. SCHWETZ et al			
	AB	5,728,635	03/17/98	H. KOBAYASHI et al			
	AC	6,001,760	12/14/99	Y. KATSUDA et al			
	AD	4,478,785	10/23/84	I.C. HUSEBY et al			
	AE	5,998,321	12/07/99	Y. KATSUDA et al			
	AF						

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	AG	9-48668	02/18/97	JAPAN (submitting English translation only)		
	AH	9-45753	02/14/97	JAPAN (submitting English translation only)		
	AI	5-229871	09/07/93	JAPAN (submitting English translation only)		
	AJ	3-5375	01/11/91	JAPAN (submitting English translation only)		
	AK	62-223070	10/01/87	JAPAN (submitting corr. US 4,803,183 only)		
	AL	9-48669	02/18/97	JAPAN (submitting corr. US 5,728,635 only)		
	AM	9-110405	04/28/97	JAPAN (submitting English translation only)		
	AN	60-186479	09/21/85	JAPAN (submitting English translation only)		
	AO	1-179765	07/17/89	JAPAN (submitting English translation only)		
	AP	9-315867	12/09/97	JAPAN (submitting corr. US 6,001,760 only)		
	AQ	11-312570	11/09/99	JAPAN (submitting English translation only)		
	AR	60-71576	04/23/85	JAPAN (submitting corr. US 4,478,785 only)		
	AS	5-101871	04/23/93	JAPAN (submitting English translation only)		
	AT	6-151332	05/31/94	JAPAN (submitting English translation only)		
	AU	11-100270	04/13/99	JAPAN (submitting corr. US 5,998,321 only)		
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OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, etc.)

	AW	
	AX	
	AY	
	AZ	☐ Additional References sheet(s) attached

Examiner	Date Considered

*Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.